

## THE ULTRA-COMPACT BINARY CANDIDATE

### KUV 23182+1007 IS A BRIGHT QUASAR

SOUTHWORTH, J.<sup>1</sup>; SCHWOPE, A.<sup>2</sup>; GÄNSICKE, B. T.;<sup>1</sup> SCHREIBER, M. R.<sup>3</sup>

<sup>1</sup> Department of Physics, University of Warwick, Coventry, CV4 7AL, UK, email: j.k.taylor@warwick.ac.uk, Boris.Gaensicke@warwick.ac.uk

<sup>2</sup> Astrophysikalisches Institut Potsdam, An der Sternwarte 16, 14482 Potsdam, Germany

<sup>3</sup> Departamento de Física y Astronomía, Universidad de Valparaíso, Avenida Gran Bretaña 1111, Valparaíso, Chile

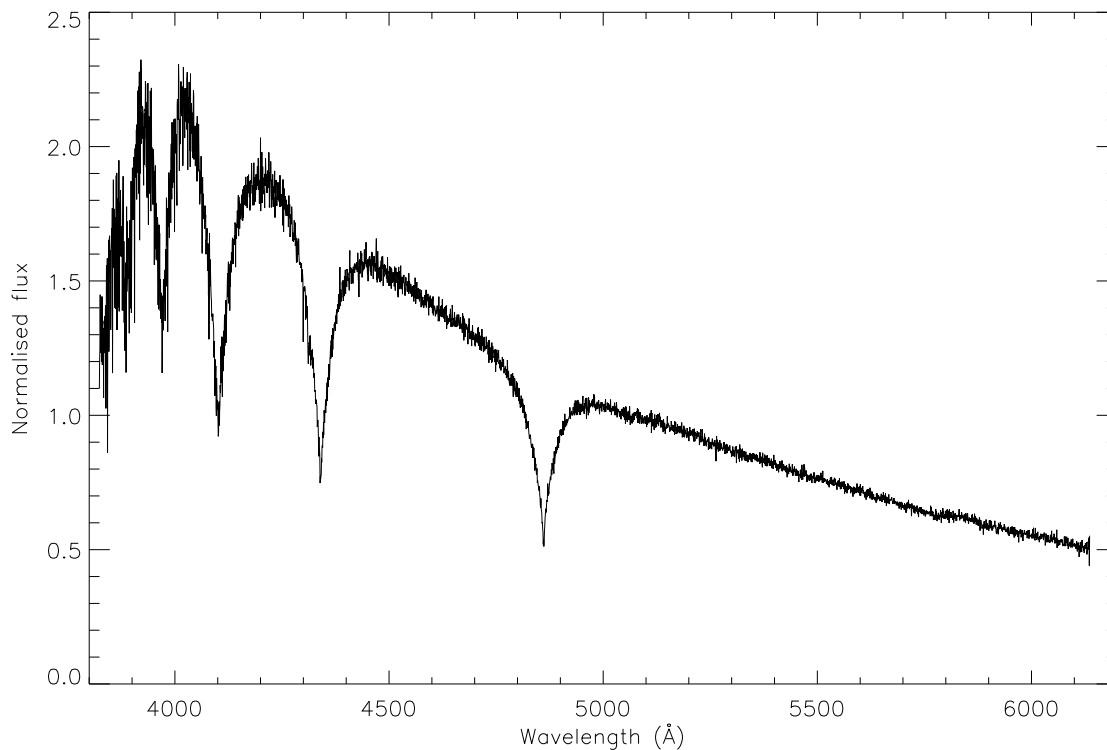
*KUV 23182+1007 was identified as a blue object in the Kiso UV Survey in the 1980s. Classification-dispersion spectroscopy showed a featureless continuum except for a strong emission line in the region of He II 4686 Å. This is a hallmark of the rare AM CVn class of cataclysmic variable star, so we have obtained a high-S/N blue spectrum of this object to check its classification. Instead, the spectrum shows a strong quasar-like emission line centred on 4662 Å. Comparison with the SDSS quasar template spectra confirms that KUV 23182+1007 is a quasar with a redshift of  $z = 0.665$ .*

The Kiso Ultraviolet Survey (Noguchi, Maehara & Kondo 1980; Kondo et al. 1984) identified 1186 objects with blue colours in a set of fields observed using the 1.0 m Schmidt telescope of Kiso Observatory. Classification-dispersion spectroscopy of these objects were presented in a series of papers by Wegner and colleagues. The spectra of three objects, KUV 01584–0939, KUV 23182+1007 KUV 23061+1229, were given by Wegner, Boley & Swanson (1987) and Wegner & McMahan (1988). All three of these showed an interesting strong emission in the region of the He II 4686 Å spectral line.

However, confusion arose between the objects KUV 23182+1007 and KUV 23061+1229 in Wegner & McMahan (1988). In that work, both objects were found to have He II 4686 Å emission lines (with some night-to-night variability noted), but the names in the figure titles and figure captions were in mutual disagreement. Koester et al. (2001) have since found that KUV 23061+1229 is a white dwarf of type DA.

Strong He II emission is a characteristic of the rare AM CVn class of cataclysmic variable star (Warner 1995; Southworth et al., 2006). These objects are particularly interesting ultra-short period helium-rich systems which are thought to be interacting binaries composed of two degenerate objects, the mass donor being a helium white dwarf. KUV 01584–0939 has since been confirmed to be an AM CVn star (Warner & Woudt 2002; Espaillat et al. 2005), and is included in the *General Catalogue of Variable Stars* under the name ES Ceti.

As very few AM CVn systems are known we have obtained a spectrum of the second of the objects, KUV 23182+1007, in order to investigate its classification as a cataclysmic variable. We also obtained a spectrum of KUV 23061+1229 in order to confirm that it is a white dwarf and to fully clear up the confusion over the identities of these two objects. For these observations we adopted the object identifications and sky co-ordinates as given by the CDS *Simbad* tool<sup>1</sup>.



**Figure 1.** Magellan/LDSS3 spectrum of the second AM CVn candidate, KUV 23061+1229, confirming that this object is a DA white dwarf.

Two consecutive long-slit spectra of KUV 23182+1007, immediately followed by one spectrum of KUV 23061+1229, were obtained on the night of 2007 May 19. We used the LDSS3 spectrograph attached to the 6.5 m Magellan Clay telescope at Las Campanas Observatory, Chile. The VPH\_Blue grism was used along with a slit width of  $0.75''$ , giving a useful wavelength coverage of 4000–6130 Å (depending on brightness) at a reciprocal dispersion of  $0.68 \text{ Å px}^{-1}$ . From the arc lamp and sky lines we estimate a resolution of approximately  $2 \text{ Å}$ . Wavelength and flat-field calibration was achieved using observations of helium/neon/argon and quartz lamps, taken immediately after the science spectra and at the same sky position. The two science spectra of KUV 23182+1007 have been combined and rebinned to increase the signal-to-noise ratio, resulting in a single spectrum with a reciprocal dispersion of  $2 \text{ Å px}^{-1}$ . The effective midpoint of this observation is HJD 2 454 240.88628. The midpoint of the spectrum of KUV 23061+1229 occurred at HJD 2 454 240.90236.

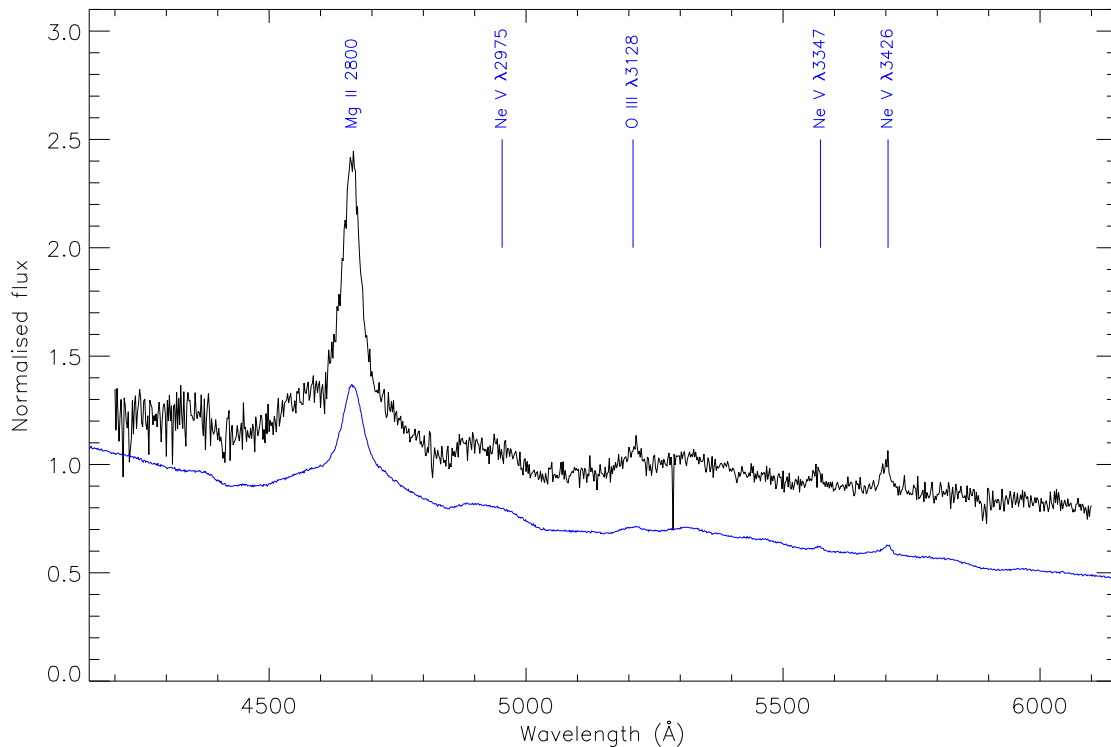
The spectrum of KUV 23061+1229 (Fig. 1) is clearly that of a DA white dwarf, in agreement with the results of Koester et al. (2001) and its inclusion in the white dwarf

<sup>1</sup><http://simbad.u-strasbg.fr/simbad/sim-fid>

catalogue of McCook & Sion (1999). We have therefore adopted the atmospheric parameters found by Koester et al. (2001) to calculate a model spectrum (Gänsicke, Beuermann & de Martino 1995) of KUV 23061+1229 and used this to divide out the wavelength-dependent response function of the spectrograph from the spectrum of KUV 23182+1007.

The KUV 23182+1007 spectrum is plotted in Fig. 2 and shows a strong emission line at 4660 Å which we identify to be the Mg 2800 Å line which is a characteristic feature of quasar spectra. In Fig. 2 we have also plotted a template quasar spectrum<sup>2</sup> from the *Sloan Digital Sky Survey* to which we have applied a redshift of  $z = 0.665$ . It can be seen that several additional quasar emission lines match the spectrum of KUV 23182+1007, confirming that this object is a bright quasar with a redshift of  $z = 0.665$ .

The large width of the Mg II line ( $\text{FWHM} \sim 50 \text{ Å} \equiv \sim 5000 \text{ km s}^{-1}$ ) indicates that KUV 23182+1007 is a type I AGN. Using  $\Lambda_{\text{CDM}}$  cosmological parameters, the distance modulus is 43.0. With the observed  $R$ -band apparent magnitude  $m_R = 17.5$  (a proxy for the rest-frame  $B$ -band magnitude) the absolute rest-frame  $B$ -band magnitude becomes  $M_B = -25.5$ , which confirms that this object is a quasar with a typical absolute brightness (Veron-Cetty & Veron 2006).



**Figure 2.** Magellan/LDSS3 spectrum of the main AM CVn candidate, KUV 23182+1007 (upper solid line), after combining and rebinning. A template quasar spectrum from the SDSS is also shown (lower solid line) after applying a redshift of  $z = 0.665$  to the wavelength scale. The stronger quasar emission lines are labelled with their rest wavelengths, taken from Vanden Berk et al. (2001).

As active galactic nuclei are often X-ray sources we have investigated the XMM-Newton and ROSAT databases for sources at the position of KUV 23182+1007. This region

<sup>2</sup>The spectrum was obtained from <http://www.sdss.org/dr5/algorithms/spectemplates/spDR2-029.fit>

of sky has not been observed using pointed observations by these satellites. However, the ROSAT All-Sky Survey<sup>3</sup> (Voges et al., 1999, 2000) includes an exposure of 444 s of this position, in which a source RXS J232044.6+102354 is detected with a count rate of  $0.0249 \pm 0.0094 \text{ counts s}^{-1}$ . This is within  $6''$  of the position of KUV 23182+1007, and over  $35'$  from the next nearest X-ray source. Given the quoted ROSAT positional error of  $15''$ , this is a strong detection. The detected X-ray emission is consistent with our identification of KUV 23182+1007 as a quasar.

We have therefore clearly identified that KUV 23182+1007 is an X-ray emitting quasar with a redshift of  $z = 0.665$ , and confirmed that KUV 23061+1229 is a normal DA white dwarf. The classification of KUV 23182+1007 in *Simbad* and catalogues of cataclysmic variables (Downes et al. 2001; Ritter & Kolb 2003) should be corrected. This report is intended to avoid other researchers using valuable telescope time to investigate the basic properties of KUV 23182+1007.

#### References:

- Downes, R. A., Webbink, R. F., Shara, M. M., Ritter, H., Kolb, U., Duerbeck, H. W., 2001, *PASP*, **113**, 764
- Espallat, C., Patterson, J., Warner, B., Woudt, P., 2005, *PASP*, **117**, 189
- Gänsicke, B. T., Beuermann, K., de Martino, D., 1995, *A&A*, **303**, 127
- Koester, D., et al., 2001, *A&A*, **378**, 556
- Kondo, M., Noguchi, T., Maehara, H., 1984, *Ann. Tokyo Astron. Obs.*, **20**, 130
- McCook, G. P., Sion, E. M., 1999, *ApJS*, **121**, 1
- Noguchi, T., Maehara, H., Kondo, M., 1980, *Ann. Tokyo Astron. Obs.*, **18**, 55
- Ritter, H., Kolb, U., 2003, *A&A*, **404**, 301
- Southworth, J., et al., 2006, *MNRAS*, **373**, 687
- Vanden Berk, D. E., et al., 2001, *AJ*, **122**, 549
- Veron-Cetty, M. P., Veron, P., 2007, *A&A*, **455**, 773
- Voges, W., et al., 1999, *A&A*, **349**, 389
- Voges, W., et al., 2000, *IAU Circ.*, **7432**
- Warner, B., 1995, *Cataclysmic Variable Stars*, Cambridge University Press
- Wegner, G., Boley, F. I., Swanson, S. R., McMahan, R. K., 1987, in IAU Coll. 95: Second Conference on Faint Blue Stars, eds. A. G. D. Philip, D. S. Hayes & J. W. Liebertm L. Davis Press Inc., p. 501
- Wegner, G., McMahan, R. K., 1988, *AJ*, **96**, 1933
- Woudt, P., Warner, B., 2002, *PASP*, **114**, 129

---

<sup>3</sup>The ROSAT All-Sky Survey catalogue can be accessed using the CDS *VizieR* service at <http://cdsweb.u-strasbg.fr/viz-bin/VizieR-2?-source=IX/29>